

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE

February 2000

BUDGET ACTIVITY

02 - Applied Research

PE NUMBER AND TITLE

0602202F Human Effectiveness Applied Research

COST (\$ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost	61,243	70,494	62,619	60,301	59,720	65,780	68,758	Continuing	TBD
621123 Manpower, Personnel, and Training	12,293	16,578	11,956	11,567	11,078	12,927	13,450	Continuing	TBD
621710 Deployment and Logistics Technologies	3,198	5,805	6,367	7,877	7,337	7,244	7,338	Continuing	TBD
621900 Environmental Quality Technology	3,457	2,766	0	0	0	0	0	Continuing	TBD
627184 Crew Technology	30,220	36,844	33,657	29,993	30,335	35,130	37,204	Continuing	TBD
627757 Directed Energy Bioeffects	12,075	8,501	10,639	10,864	10,970	10,479	10,766	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0	0

Note: In FY 2000, studies in support of Distributed Mission Training will move from Project 627184 to Project 621123, and the toxicology hazards research program will move from Project 627757 to Project 621710. Project 621900 was terminated after FY 1999, but Congress added funding in FY 2000.

(U) **A. Mission Description**

This program establishes technology feasibility and develops the technology base for Air Force human effectiveness requirement needs for weapon systems, operational readiness, and environmental quality. The program addresses crew systems interfaces, crew protection, warfighter training, deployment and sustainment of expeditionary forces, and environmental safety and quality. Crew technologies increase the performance of humans in weapon systems operation by improving aircrew life support systems, man-machine integration (to include aircraft information display systems), and protection from dynamic forces (acceleration/escape/windblast). Warfighter training technologies focus on the development and evaluation of new methods and technologies in support of Air Force training and education requirements. Deployment and sustainment technologies focus on reducing manpower required to operate and support weapon systems by increasing weapon systems supportability and affordability, improving wartime logistics planning, developing occupational and operational exposure safety guidelines for militarily relevant toxicants, and modeling human cognitive functioning on complex tasks to enhance operational performance. Directed energy bioeffect technologies focus on protection from militarily relevant electromagnetic radiations and directed energy systems (lasers and radio frequency emitting weapons, radars, and communication systems). Environmental quality technologies address detection, control, reduction, and disposal of pollutants from Air Force operations; and the clean-up of contaminated Air Force sites. Payoff from these technology development efforts is to improve combat effectiveness by expanding all parameters defining operational performance limits.

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02 - Applied Research

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0602202F Human Effectiveness Applied Research(U) **A. Mission Description Continued**

Note: In FY 2000, Congress added \$0.8 million for Materials and Processes for Metal Cleaning, Corrosion Control and Coatings, \$3.6 million for Behavioral Science Research under Air Force Research Laboratory, \$3.0 million for Solid State Electrolyte Oxygen Generator, \$1.7 million for Oxygen Research, \$2.0 million for Environmental Quality Technology, \$2.0 million for Sustained Operations, \$0.7 million for Spatial Disorientation, \$0.4 million for Altitude Protection, \$1.2 million for Physiology, \$2.4 million for Information Training, and \$1.7 million for Space Training, which explains the perceived decrease in FY 2001 and out.

(U) **B. Budget Activity Justification**

This program is in Budget Activity 2, Applied Research, since it develops and determines the technical feasibility and military utility of evolutionary and revolutionary technologies. This Applied Research program establishes technology feasibility and develops the technology base for Air Force human interface needs required for weapon systems, operational readiness, and environmental quality.

(U) **C. Program Change Summary (\$ in Thousands)**

	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>Total Cost</u>
(U) Previous President's Budget (FY 2000 PBR)	58,114	51,512	56,629	
(U) Appropriated Value	60,805	71,012		
(U) Adjustments to Appropriated Value				
a. Congressional/General Reductions	-2,691	-13		
b. Small Business Innovative Research	-937			
c. Omnibus or Other Above Threshold Reprogram		-255		
d. Below Threshold Reprogram	4,409			
e. Rescissions	-343	-250		
f. Other				
(U) Adjustments to Budget Years Since FY 2000 PBR			5,990	
(U) Current Budget Submit/FY 2001 PBR	61,243	70,494	62,619	TBD

(U) **Significant Program Changes:**

Increase in FY 2001 is due to increased emphasis on aviation safety to include countermeasures to warfighter fatigue, improving pilot performance under high gravitational forces, and countering spatial disorientation.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2A Exhibit)								DATE February 2000	
BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research				PROJECT 621123	
COST (\$ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621123 Manpower, Personnel, and Training	12,293	16,578	11,956	11,567	11,078	12,927	13,450	Continuing	TBD
<p>(U) <u>A. Mission Description</u> This project develops and evaluates new methods and technologies in support of Air Force training and education requirements in a variety of specific areas, including: aircrew training; technical training; logistics training; mission rehearsal; training in support of complex decision making; space operations training; information warfare training; and warfare readiness training. It investigates the spectrum of new and advanced training and education technologies for optimal ways to determine needs and deficiencies, design and implement training, and evaluate training effectiveness. It develops and evaluates specific training systems, desktop tutors, courseware development tools and technologies, assessment methodologies, and simulation-based systems to determine how to achieve maximum learning effectiveness for specific needs at minimum cost. This project will contribute to a more highly trained and flexible cadre of personnel and reduce the cost of maintaining crew, aircraft, and support personnel readiness. This program develops technologies to increase operational readiness by providing more effective methods and approaches to classify, assign, train, assess, and retain personnel. This program focuses on reducing the manpower required to operate and support weapon systems and on improving the effectiveness of the operators, maintainers, and other support personnel for those systems.</p>									
<p>(U) <u>FY 1999 (\$ in Thousands)</u></p>									
(U) \$5,780	Developed technologies required to enhance the integrated Distributed Mission Training (DMT) environment by incorporating space and information operations systems and by developing mission rehearsal training technologies, a more representative electronic combat environment and High Level Architecture (HLA) compliant systems.								
(U) \$2,938	Developed Air Force training guidelines, instructional scenarios, and techniques for use in Air Force aircrew, space, and information operations mission training.								
(U) \$2,714	Refined intelligent computer adaptive instruction authoring system based on knowledge representation/student modeling technologies and knowledge-based technologies for curriculum planning and media selection.								
(U) \$861	Developed concept and technologies to enable a warfare operations center by creating performance specifications for a seamless, integrated information system consisting of mission planning, automated brief/debrief, simulation, academics, weapon systems, and Command, Control and Information systems.								
(U) \$12,293	Total								
<div style="display: flex; justify-content: space-between; margin-top: 20px;"> Project 621123 Page 3 of 20 Pages Exhibit R-2A (PE 0602202F) </div>									

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 621123
(U) <u>A. Mission Description Continued</u>		
(U) <u>FY 2000 (\$ in Thousands)</u>		
(U) \$4,695	Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated Distributed Mission Training (DMT) environment. Research will increase and enhance the quality of training and mission rehearsal for the warfighter. Develop cockpit sensors, which replicate real world responses to outside stimuli. Explore requirements for long haul networking in the areas of computer bandwidth to see how many moving models can be on the database without causing performance degradation and latency, and to see how distance between simulators will affect performance. Complete the development of the threat library, which covers all known threats.	
(U) \$10,992	Develop Air Force training guidelines, instructional scenarios, and techniques by transitioning combat aerial training technologies and performance measurement systems into aircrew, space, and information operations environments. Methods and technologies will significantly improve the effectiveness and efficiency of aerospace operations, command and control, training development, mission rehearsal, and refresher training. Begin to develop an internet-based integrated team decision support system. Perform detailed task and functional analyses to specify the information requirements, sources, and levels of interoperability necessary to develop an integrated space mission control training and rehearsal system. Identify key training and operational knowledge, skills and tasks, and develop specifications for competency-based training and rehearsal for both DMT and operational flying training.	
(U) \$891	Develop concept and technologies to enable a Warfare Operations Center (WOC) by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Implement a deployable personal agent into an existing distributed command and control simulation for training, assessment, and aiding the warfighter.	
(U) \$16,578	Total	
(U) <u>FY 2001 (\$ in Thousands)</u>		
(U) \$5,988	Research new computer representation technologies and perceptual issues confronting the development of new visual systems to enhance the integrated DMT environment. Research will increase and enhance the quality of training and mission rehearsal for the warfighter. Conduct experiments to determine the extent to which various cues provided by simulator visual systems contribute to the effectiveness of the display imagery. Complete feasibility study and begin the establishment of a DMT networking standard to be employed by the entire DoD modeling and simulation community. Investigate new computer architectures and data manipulation to provide real-time modeling of multi-sensor imagery.	
(U) \$5,172	Develop tools and strategies for identifying and improving combat mission training and rehearsal and for distributing training and performance support to operational forces. Begin feasibility study to embed and evaluate instructional principles in DMT simulations. Complete feasibility study of integrated intelligence, surveillance, and reconnaissance (ISR) data utility for aircrew mission planning and execution. Conduct knowledge engineering for ground-based satellite controller training and develop initial capability for Space Based Infrared System operator	
Project 621123	Page 4 of 20 Pages	Exhibit R-2A (PE 0602202F)

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research										
		PROJECT 621123									
<p>(U) <u>A. Mission Description Continued</u></p> <p>(U) <u>FY 2001 (\$ in Thousands) Continued</u></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 80%;">training and performance support, and continue study of integrating command and control systems of the warfare operations center with the Distributed Mission Training (DMT) environment.</td> </tr> <tr> <td>(U)</td> <td>\$796</td> <td>Develop Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Develop and implement tools and simulation for training and assessment of performance in two separate command and control information systems. Demonstrate new training and team dynamic protocols to operational users.</td> </tr> <tr> <td>(U)</td> <td>\$11,956</td> <td>Total</td> </tr> </table> <p>(U) <u>B. Project Change Summary</u> Not Applicable.</p> <p>(U) <u>C. Other Program Funding Summary (\$ in Thousands)</u></p> <p>(U) Related Activities:</p> <p>(U) PE 0602233N, Mission Support Technology: Personnel, Training, and Simulation Technology Area.</p> <p>(U) PE 0602716A, Human Factors Engineering Technology Development.</p> <p>(U) PE 0602727A, Non-System Training Devices Technology.</p> <p>(U) PE 0602785A, Manpower, Personnel, and Training Technology.</p> <p>(U) PE 0603106F, Logistics Systems Technology.</p> <p>(U) PE 0603227F, Personnel, Training, and Simulation Technology</p> <p>(U) PE 0604227F, Distributed Mission Training (DMT).</p> <p>(U) PE 0604243F, Manpower, Personnel, and Training Development.</p> <p>(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</p> <p>(U) <u>D. Acquisition Strategy</u> Not Applicable.</p> <p>(U) <u>E. Schedule Profile</u></p> <p>(U) Not Applicable.</p>					training and performance support, and continue study of integrating command and control systems of the warfare operations center with the Distributed Mission Training (DMT) environment.	(U)	\$796	Develop Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Develop and implement tools and simulation for training and assessment of performance in two separate command and control information systems. Demonstrate new training and team dynamic protocols to operational users.	(U)	\$11,956	Total
		training and performance support, and continue study of integrating command and control systems of the warfare operations center with the Distributed Mission Training (DMT) environment.									
(U)	\$796	Develop Warfare Operations Center (WOC) technologies by integrating the command and control systems of the WOC with the DMT environment. The generated tools will provide real-time performance support with automated remediation leading to a 50% reduction in training costs with no reduction in training effectiveness. Develop and implement tools and simulation for training and assessment of performance in two separate command and control information systems. Demonstrate new training and team dynamic protocols to operational users.									
(U)	\$11,956	Total									
<div style="display: flex; justify-content: space-between;"> Project 621123 Page 5 of 20 Pages Exhibit R-2A (PE 0602202F) </div>											

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BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research				PROJECT 621710	
COST (\$ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
621710 Deployment and Logistics Technologies	3,198	5,805	6,367	7,877	7,337	7,244	7,338	Continuing	TBD
<p>(U) <u>A. Mission Description</u> This project investigates and researches technologies to support the enhancement of the deployment and sustainment technologies critical to the goals and requirements of Agile Combat Support and Air Expeditionary Force (AEF) operations. The research focuses on technologies with the potential to: reduce the time required for units to plan, pack up, and deploy; reduce airlift requirements while enhancing deployed capability; enhance sustainment of deployed forces in contingency environments; improve logistics support for both combat and peacetime operations; and develop toxicological tools and technology to minimize the health risks and mission impact to DoD personnel from exposure to hazardous chemicals while also reducing weapon system life cycle cost.</p> <p>(U) <u>FY 1999 (\$ in Thousands)</u></p> <p>(U) \$670 Explored and defined highly reliable, low footprint, multi-function, rapid on-load/off-load, and ground movement technology concepts which will increase deployment speed and decrease airlift requirements in support of agile combat support and rapid global mobility goals.</p> <p>(U) \$1,082 Explored and developed technology options to improve agile combat support capabilities by assessing alternative input devices, such as electro-oculographic and electromyographic capabilities, to be used in various maintenance environments which are loud (prohibiting voice control capability), and requiring free hands (prohibiting manual control). Investigated advanced user interfaces to support wing level logistics decision making to enhance response time and unit capability in AEF operations.</p> <p>(U) \$1,446 Adapted and refined information technologies to enhance logistics and deployment planning capabilities by defining and evaluating advanced knowledge representation schemes and computational linguistics methods to automatically extract maintenance manual information for weapon systems design data.</p> <p>(U) \$3,198 Total</p> <p>(U) <u>FY 2000 (\$ in Thousands)</u></p> <p>(U) \$297 Develop technologies for improved cargo handling and improved support of space assets to better support weapon systems and reduce logistics support costs. Complete feasibility analyses and development of initial technology concepts for improved cargo handling at aerial ports and deployed locations and for improved space systems supportability.</p> <p>(U) \$2,782 Develop logistics readiness and sustainment technology options and perform feasibility studies to support large scale advanced technology development programs. These experiments provide critical information for technology integration and application to advanced technology developments which support AEF initiatives. Identify diagnostic strategies and data requirements to support the advanced prognostic/diagnostic program which will reduce aircraft down time. Develop enabling technology for innovative software architectures for more accurate</p>									
<div style="display: flex; justify-content: space-between;"> Project 621710 Page 6 of 20 Pages Exhibit R-2A (PE 0602202F) </div>									

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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	PROJECT 621710
<p>(U) <u>A. Mission Description Continued</u></p> <p>(U) <u>FY 2000 (\$ in Thousands) Continued</u></p> <p>(U) \$2,726 representation of human behavior in synthetic environments. Demonstrate and apply predictive human health assessment models to accurately characterize the human health risk associated with exposure to operational compounds and materials for force protection. Characterize the health hazard to flight operations personnel exposed to jet fuels (JP-8) and various additive compounds. Develop a science-based standard that accurately reflects the human health consequences of widespread contamination by solvent compounds used in maintenance processes.</p> <p>(U) \$5,805 Total</p> <p>(U) <u>FY 2001 (\$ in Thousands)</u></p> <p>(U) \$1,805 Develop logistics sustainment technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more supportable weapon systems at reduced logistics support costs. Develop software architectures to transform procedural maintenance instructions into graphic-oriented computer simulations for validation analysis. Develop neural network concepts for application to high-leverage areas of depot repair parts demand and resource forecasting.</p> <p>(U) \$1,762 Develop logistics readiness technology options and perform feasibility studies to support large-scale advanced technology development programs. These technologies will lead to more efficient utilization of logistics resources for Air Expeditionary Force (AEF) operations. Investigate various technology to retrofit aircraft with automated sensors to collect and record system performance data for enhanced capability to diagnose and predict component failures. Explore technology to automatically collect asset status information to provide real-time information for management of logistics processes and support of deployment operations.</p> <p>(U) \$2,800 Demonstrate and apply predictive human health assessment models to accurately characterize the human health risks associated with exposure to operational compounds and materials for force protection. Establish a health-based exposure standard for an Air Force missile fuel oxidizer that has contaminated large areas of the western United States. Apply predictive tools to assist fuels developers in rapidly screening various additives for toxicity.</p> <p>(U) \$6,367 Total</p> <p>(U) <u>B. Project Change Summary</u> Not Applicable.</p>		
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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602202F Human Effectiveness Applied Research	621710
<p>(U) <u>C. Other Program Funding Summary (\$ in Thousands)</u></p> <p>(U) Related Activities:</p> <p>(U) PE 0602233N, Mission Support Technology: Personnel, Training, and Simulation Technology Area.</p> <p>(U) PE 0602716A, Human Factors Engineering Technology Development.</p> <p>(U) PE 0603106F, Logistics Systems Technology.</p> <p>(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</p> <p>(U) <u>D. Acquisition Strategy</u></p> <p>Not Applicable.</p> <p>(U) <u>E. Schedule Profile</u></p> <p>(U) Not Applicable.</p>		
<p>Project 621710</p> <p>Page 8 of 20 Pages</p> <p>Exhibit R-2A (PE 0602202F)</p>		

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BUDGET ACTIVITY 02 - Applied Research				PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research				PROJECT 621900		
COST (\$ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost	
621900 Environmental Quality Technology	3,457	2,766	0	0	0	0	0	0	Continuing	TBD
<p>(U) <u>A. Mission Description</u> This project develops technologies to characterize the chemistry of Air Force-generated pollutants and toxic materials, assesses their interaction with the environment, and develops reduction/destruction and control techniques with the objective to reduce the cost and increase the effectiveness of technologies that protect the environment; emphasis is placed on pollution prevention technologies. New Air Force fuels and chemicals are analyzed to identify and prevent possible environmental problems. Materials are investigated and new processes explored to assess and reduce environmental risks. Monitoring and control technologies are developed for Air Force operations by using novel instrumentation, characterization, and modeling techniques.</p> <p>(U) <u>FY 1999 (\$ in Thousands)</u></p> <p>(U) \$980 Investigated and developed environmentally acceptable replacement materials and processes to reduce the cost of weapon systems sustainment by developing new selection criteria for Air Force industrial solvents and fuels, and by characterizing the air quality effects of Air Force volatile materials.</p> <p>(U) \$888 Developed environmental instrumentation for chemical detection and monitoring and process controls by identifying and correcting unnecessary Air Transport and Dispersion (ATD) launch holds and reducing liability risks. Developed techniques to accurately characterize Air Force-generated particulate matter and developed innovative instrumentation to detect chlorinated solvents, explosives, and other Air Force-monitored chemicals.</p> <p>(U) \$1,589 Reduced weapon systems sustainment costs and enhanced Air Force readiness by developing engineering tools to isolate and synthesize enzymes for perchlorate chlorate and chlorite reduction. Converted propellant from missiles and rockets to benign compounds. Characterized strategies for energy generation and water recovery from waste treatment systems. Enhanced DoD capability to contain and control regulated emissions from depainting and other corrosion-control operations. Studied environmental interactions of advanced fuels and solvents.</p> <p>(U) \$3,457 Total</p> <p>(U) <u>FY 2000 (\$ in Thousands)</u></p> <p>(U) \$967 Develop filtration materials and processes to protect U.S. forces from long-term health consequences from exposure to hazardous materials. Develop advanced filter materials and processes to remove and destroy operationally generated hazardous organic materials and particulate contaminants. Define warfare agent interaction with Air Force unique materials.</p> <p>(U) \$1,111 Develop integrated materials technologies that demonstrate the capability to identify, monitor, and mitigate/neutralize toxic risks. Develop sensor materials for detection, mitigation, avoidance, and warning of operational toxic materials. Identify tracer emissions for detection and</p>										
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BUDGET ACTIVITY 02 - Applied Research	PE NUMBER AND TITLE 0602202F Human Effectiveness Applied Research	
		PROJECT 621900
<p>(U) <u>A. Mission Description Continued</u></p> <p>(U) <u>FY 2000 (\$ in Thousands) Continued</u></p> <p style="margin-left: 40px;">modeling of chemically-based atmospheric threats.</p> <p>(U) \$688 Discover and characterize novel enzymatic reactions for applications in biotransformations and biocatalytic synthesis of high-performance materials. Explore biotransformation and biocatalytic generation of Air Force unique materials.</p> <p>(U) \$2,766 Total</p> <p>(U) <u>FY 2001 (\$ in Thousands)</u></p> <p>(U) \$0 No Activity.</p> <p>(U) \$0 Total</p> <p>(U) <u>B. Project Change Summary</u></p> <p style="margin-left: 40px;">Not Applicable.</p> <p>(U) <u>C. Other Program Funding Summary (\$ in Thousands)</u></p> <p>(U) Related Activities:</p> <p>(U) PE 0601102F, Defense Research Sciences</p> <p>(U) PE 0602102F, Materials</p> <p>(U) PE 0602203F, Aerospace Propulsion.</p> <p>(U) PE 0603112F, Advanced Materials for Weapon Systems.</p> <p>(U) PE 0603211F, Aerospace Structure</p> <p>(U) PE 0603723F, Environmental Engineering Technology.</p> <p>(U) PE 0603716D, Strategic Environmental Research and Development Program.</p> <p>(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</p> <p>(U) <u>D. Acquisition Strategy</u></p> <p style="margin-left: 40px;">Not Applicable.</p> <p>(U) <u>E. Schedule Profile</u></p> <p>(U) Not Applicable.</p>		
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COST (\$ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
627184 Crew Technology	30,220	36,844	33,657	29,993	30,335	35,130	37,204	Continuing	TBD
<p>(U) <u>A. Mission Description</u> This project develops the technology required to improve human performance, protection, and survivability in operational environments. This is accomplished by defining the physical and cognitive parameters, capabilities, and limits of systems operators; determining human responses to operational stresses such as noise, impact, vibration, sustained acceleration, spatial disorientation, altitude, workload, and sustained operations; and optimizing the human-machine interface. The project produces human-centered design criteria, guidelines, and automated design tools for the development of effective technologies for information display, team communications, crew scheduling and fatigue management, control interfaces, crew station layout and functional integration, emergency escape, crash protection, aircrew oxygen systems, acceleration protection, and aircrew life support.</p>									
<p>(U) <u>FY 1999 (\$ in Thousands)</u></p>									
(U) \$2,294	Continued to develop unobtrusive, reliable predictors of human system effectiveness based on crew workload and situational awareness and applied results to KC-135 cockpit upgrade. Completed international validation and selected predictive workload model to advance technology for human performance design assessment. Validated model and metrics with simulation of Unmanned Aerial Vehicle (UAV) control station, including assessment of UAV target localization and improved controller. Completed data collection for cockpit accommodation mapping of Air Force inventory aircraft, and transitioned accommodation method to fighter aircraft. Continued international whole-body three-dimensional size survey for new design tool, collecting data in the U.S., Canada, and the Netherlands.								
(U) \$5,610	Continued to develop system design technologies that integrate human factors data for workstations by developing process models to streamline the sharing of data among intelligence analysts and command centers, and by initiating development of multi-sensory adaptive control as a new design technology. Demonstrated 10-20% reduction in Air Tasking Order preparation time via speech command interface, and delivered cognitive task analysis to Air Intelligence Agency. Completed plan for international collaboration with Australia on multi-sensory technology.								
(U) \$7,548	Continued to develop visual display technology for improved human-machine interfaces and demonstrated adaptive interface technology, including integrated display and information processing standards, and design alternatives for next generation helmet-mounted sights/displays, ejection-safe, panoramic night vision goggles with external sensor inputs to enhance night operations, and a pilot-vehicle interface that adapts to pilot physiological and behavioral state. Developed standard test procedures for night vision goggles transmissivity, mapped the windscreen angular deviation for various fighter aircraft, and demonstrated multi-color stacked active matrix display advances.								
(U) \$1,964	Continued expansion of audio technologies to establish new information management methods to improve operator performance in high workload environments. Transitioned three-dimensional audio display and signal process technology to Cheyenne mountain operational								
<div style="display: flex; justify-content: space-between;"> Project 627184 Page 11 of 20 Pages Exhibit R-2A (PE 0602202F) </div>									

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BUDGET ACTIVITY	PE NUMBER AND TITLE	PROJECT
02 - Applied Research	0602202F Human Effectiveness Applied Research	627184
(U) <u>A. Mission Description Continued</u>		
(U) <u>FY 1999 (\$ in Thousands) Continued</u>		
	environment. Demonstrated reduced cost sonic boom monitoring systems for environmental compliance.	
(U) \$1,442	Continued aircrew life support and performance research including the effect of high G on pilot color perception and the ability to discern color cues on head-up and head-down displays.	
(U) \$3,923	Developed tolerance criteria for assessing effects of forces experienced during escape, sustained, and transient accelerations on crew safety and performance while using head or helmet-mounted equipment.	
(U) \$2,314	Improved integrated mission rehearsal training technologies for aircrew and battlestaff in simulated and field extended/continued operations and information warfare application.	
(U) \$1,901	Continued development of operationally relevant cognitive performance assessment technologies and mathematical models that predict the impact of fatigue on decision making and operator performance during sustained operations; evaluated pharmaceuticals and other countermeasures as an aid to aircrew sleep management and alertness enhancement during sustained Global Attack and Global Mobility missions.	
(U) \$1,235	Continued development of high-altitude protection technologies and validated the altitude decompression sickness risk assessment model for use in mission planning; continued investigation of spatial disorientation mechanisms and evaluated candidate formats for attitude symbology in off-axis helmet-mounted displays.	
(U) \$1,989	Supported the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program.	
(U) \$30,220	Total	
(U) <u>FY 2000 (\$ in Thousands)</u>		
(U) \$3,973	Develop interface technologies for crew station and equipment accommodation, multi-sensory displays, adaptive controls, and performance metrics. Interface technologies promote cognitive and physical fit with air and ground control stations to enhance effectiveness and safety. Continue to develop reliable workload predictors and a near-real-time classification of crew overload and demonstrate a next-generation crew station under joint Air Force-France agreement. Demonstrate improved control station for uninhabited aerial vehicles. Plan validation of inventory cockpit accommodation maps and complete data analysis of U.S. part of multi-national whole-body three-dimensional survey.	
(U) \$3,013	Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Complete a cognitive task analysis and identify information requirements for an Information Warfare Watch Center. Demonstrate high-accuracy speech recognition in airborne C-135 environment and demonstrate speech countermeasures in an operational exercise. Integrate and demonstrate voice recognition and laser pointer/tracker technologies with large screen interactive display for command center operations.	
(U) \$3,839	Develop concepts for integrating human computer interface technologies, human performance modeling tools, and real-time simulations to	
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(U) <u>A. Mission Description Continued</u>		
(U) <u>FY 2000 (\$ in Thousands) Continued</u>		
	affordably quantify operational benefit from new interface technologies. Explore new human-computer interface options for future unmanned vehicle control stations. Advance integrated control and display concepts for air operations, concentrating on effectively melding on-board data with off-board data, and on flight displays that support complex landing approaches. Draft a design notebook for tactical re-supply crew stations, and begin to develop integrated human performance models and analysis tools.	
(U) \$4,444	Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding the effects of vision through display optics, vehicle transparencies, and synthetic vision. Visual display interface technologies enhance situation awareness, warfighter performance, combat effectiveness, and survivability. Conduct studies to understand the trade off of night vision goggle optical resolution with field-of-view. Identify ways to increase sunlight readable display efficiency. Conduct study of helmet-mounted display contrast requirements for color recognition.	
(U) \$2,336	Develop and demonstrate advanced audio displays including three-dimensional audio, active noise reduction, voice control, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Conduct a feasibility demonstration of an integrated three-dimensional audio headset with noise reduction and CD quality digital audio. Demonstrate the ability to reduce the acoustic signature for special operations aircraft. Begin a program to exploit the use of audio signals to add a new capability for remote threat detection in perimeter defense.	
(U) \$1,591	Conduct altitude protection and acceleration physiology research to maximize warfighter survivability and combat effectiveness in the aerospace flight environment. Research will define life support equipment design concepts and procedures to enable safe flight operations at high altitudes and high sustained accelerations. Determine risks for aircrews engaged in unpressurized flight at high altitude for extended periods of time. Investigate performance and comfort issues associated with pressure breathing technology for tactical aviators.	
(U) \$5,716	Develop human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Define human impact tolerance limits, and use these to design and validate mathematical or physical models of human response to impact environments. Research will focus on full aircrew accommodation issues, including definition of ejection seat haulback/retraction criteria and spinal injury criteria to minimize probability of injury. Develop multi-axis head and neck tolerance, response, and injury criteria to minimize injury risk during ejection with helmet-mounted devices. Evaluate helmet biodynamic properties in the sustained acceleration environment and assess the physiological effects of multi-axis maneuvering.	
(U) \$2,685	Conduct warfighter fatigue and spatial disorientation countermeasures research. Results will extend and enhance cognitive performance during long-range deployment, global attack, and around the clock surge operations and explore ways to reduce aircraft mishaps due to spatial disorientation. Establish feasibility of using newly developed alertness enhancing stimulants in Air Force missions and develop fatigue avoidance mission planning technologies. Characterize spatial disorientation problems related to helmet-mounted displays, night vision goggles, and agile	
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(U) <u>A. Mission Description Continued</u>		
(U) <u>FY 2000 (\$ in Thousands) Continued</u>		
	aircraft flight profiles.	
(U) \$1,690	Develop technologies to self-produce, liquefy, store, and deliver both nitrogen enriched air and high purity oxygen for application on-board airlift aircraft. Technologies will enhance the inert gas fuel tank fire suppression system and improve capability to meet life support oxygen requirements during high altitude parachute operations. Develop miniaturized distillation column air separation techniques and cryogenic refrigeration technology and combine to generate both nitrogen and oxygen in a single integrated package.	
(U) \$2,983	Develop solid state electrolyte oxygen generation technologies for aircraft on-board oxygen generating systems to improve reliability and reduce aircraft dependence on liquid oxygen infrastructure. Pursue improvements to increase oxygen flow rates, reduce power consumption, and decrease operating temperatures of existing ion conducting ceramics technology. Investigate requirements for utilization and integration of solid state electrolyte oxygen generators as on-board systems.	
(U) \$3,580	Provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.	
(U) \$994	Conduct international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Joint demonstration determines feasibility and matures technology for a class of affordable crew stations common to airborne early warning, attack aircraft, and unmanned vehicles by exploiting virtual controls and displays. Link Australia's airborne early warning and control simulator with Air Force Research Laboratory synthesized immersion research simulator for joint experiments. Begin to develop an integrated multi-sensory crew station to demonstrate the virtual air commander concept.	
(U) \$36,844	Total	
(U) <u>FY 2001 (\$ in Thousands)</u>		
(U) \$4,227	Develop interface technologies for crew station and equipment accommodation, multi-sensory displays, adaptive controls, and performance metrics. Interface technologies promote cognitive and physical fit with air and ground control stations to enhance effectiveness and safety. Complete workload classification algorithm and incorporate into laboratory demonstration of a multi-sensory control station for uninhabited aerial vehicle operable with reduced crew size. Validate cockpit accommodation maps of inventory aircraft. Begin to develop an intelligent, on-line physical accommodation information system to optimize equipment fit, and include Dutch anthropometric data from multi-national survey.	
(U) \$3,310	Develop cognitive information technology and human speech processing and control solutions for time-critical command and control to achieve common understanding at all echelons of information operations and to improve decision-making. Develop and demonstrate new user-computer	
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(U) <u>A. Mission Description Continued</u>		
(U) <u>FY 2001 (\$ in Thousands) Continued</u>		
	interface for intelligence analysts for faster and more accurate decision-making. Continue research on speech signal processing and speech-based countermeasures for information operations.	
(U) \$4,142	Develop concepts for integrating human computer interface technologies, human performance modeling tools, and real-time simulations to affordably quantify operational benefit from new interface technologies. Complete a feasibility evaluation of an integrated control interface for unmanned vehicles, demonstrating multi-vehicle per mission operation. Identify and compare alternative console concepts for advanced space operations. Develop integrated flight path and synthetic terrain concept for primary flight reference on helmet displays, and continue to develop integrated human performance models and analysis tools.	
(U) \$4,685	Develop visual display interface technologies, specifically helmet-mounted displays, night vision technologies, large flat panel displays, and develop an understanding the effects of vision through display optics, vehicle transparencies, and synthetic vision. Visual display interface technologies enhance situation awareness, warfighter performance, combat effectiveness, and survivability. Establish helmet-mounted display symbology specifications for strike missions. Conduct study to determine the influence of helmet visor transmissivity and reflectivity on visual target detection.	
(U) \$2,642	Develop and demonstrate advanced audio displays including three-dimensional (3-D) audio, active noise reduction, voice control, and related technologies that mitigate effects of noise and enhance performance in the operational environment. Complete a feasibility demonstration of an integrated 3-D audio headset with noise reduction and CD quality digital audio. Develop acoustic processing algorithms and an intuitive human centered interface to add a new capability for remote threat detection in perimeter defense. Develop auditory symbology design criteria handbook for improving situational awareness using 3-D audio displays.	
(U) \$3,480	Develop human injury and protective systems design criteria for use against hazards encountered in emergency escape or crash environments. Research will develop technologies to ensure full aircrew population safety during all phases of aircraft and vehicle operations including emergency escape and crashes. Incorporate tolerance and injury criteria into the development of mathematical models to be used for injury assessment. Continue study to define multi-axis head and neck response during impact. Define male and female tolerance standards to improve injury prediction in dynamic environments and to optimize restraint concepts. Refine biodynamic performance assessment of helmet-mounted devices to optimize safe helmet-mounted system concepts.	
(U) \$6,476	Develop aviation safety enhancing technologies to alleviate warfighter fatigue, counter spatial disorientation, and improve pilot performance under high gravitational forces. Results will extend and enhance cognitive performance during Air Expeditionary Force deployments and long-range global attack missions, reduce mishaps due to spatial disorientation, and minimize adverse impacts of acceleration stresses on combat effectiveness. Expand the capabilities of the fatigue avoidance scheduling tool to predict the effects of pharmaceutical countermeasures on fatigue, and initiate efforts to extend the management of fatigue so as to apply its impact on decision making as a component of Information	
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(U) <u>A. Mission Description Continued</u>		
(U) <u>FY 2001 (\$ in Thousands) Continued</u>		
	Warfare strategy. Evaluate effectiveness of candidate techniques to improve spatial orientation capabilities in aircrew wearing Night Vision Goggles. Evaluate feasibility of employing innovative pressure application techniques and advanced fabrics to improve pilot performance by reducing the bulk, weight, and thermal burden of existing acceleration protection ensembles.	
(U) \$3,195	Provide human systems technology support to the joint Air Force/Defense Advanced Research Projects Agency Unmanned Combat Air Vehicle (UCAV) program. The UCAV program will demonstrate unmanned air vehicle technologies, including the remote operator control/display interface, that can extend the capability to effectively and affordably perform the 21st century combat missions of defense suppression and tactical attack.	
(U) \$1,500	Conduct international cooperative effort with Australia for Virtual Air Commanders, involving human interface technology for airborne early warning. Joint demonstration determines feasibility and matures technology for a class of affordable crew stations common to airborne early warning, attack aircraft, and unmanned vehicles by exploiting virtual controls and displays. Perform international laboratory experiment using real-time simulators linked by distributed interactive simulation technology. Demonstrate feasibility of an integrated multi-sensory crew station for virtual air commanders tailored for early warning and control mission.	
(U) \$33,657	Total	
(U) <u>B. Project Change Summary</u>		
Not Applicable.		
(U) <u>C. Other Program Funding Summary (\$ in Thousands)</u>		
(U) Related Activities:		
(U) PE 0602201F, Aerospace Flight Dynamics.		
(U) PE 0602204F, Aerospace Sensors.		
(U) PE 0602702F, Command, Control, and Communications		
(U) PE 0603205F, Aerospace Vehicle Technology.		
(U) PE 0603227F, Personnel, Training and Simulation Technology.		
(U) PE 0603231F, Crew Systems and Personnel Protection Technology.		
(U) PE 0603245F, Flight Vehicle Technology Integration.		
(U) PE 0604227F, Distributed Mission Training (DMT).		
(U) PE 0604703F, Aeromedical/Casualty Care Systems Development.		
(U) PE 0604706F, Life Support Systems.		
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<p>(U) <u>C. Other Program Funding Summary (\$ in Thousands)</u></p> <p>(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</p> <p>(U) <u>D. Acquisition Strategy</u> Not Applicable.</p> <p>(U) <u>E. Schedule Profile</u> Not Applicable.</p>		
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COST (\$ in Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
627757 Directed Energy Bioeffects	12,075	8,501	10,639	10,864	10,970	10,479	10,766	Continuing	TBD
<p>(U) <u>A. Mission Description</u> This project enables the safe operational use of Air Force directed energy weapon systems through technology development related to the biological effects of electromagnetic radiation used in, or resulting from, Air Force operations. The project identifies and mitigates the biological effects of exposure to radio frequency radiation, high power pulsed microwaves, lasers, broad band devices, and ultra-wide band pulsed fields by addressing areas such as safety, risk assessment, mission planning, and countermeasures. The project also assesses the bioeffects of non-lethal directed energy technologies for special operations, missions other than war, and peacekeeping applications. Finally, this project provides technical consultative support to other DoD programs to assess and counter optical and radio frequency radiation hazards and threats.</p> <p>(U) <u>FY 1999 (\$ in Thousands)</u></p> <p>(U) \$4,238 Conducted laser optical bioeffects research to enable countermeasures for optical hazards/threats by initiating development of guidelines for high energy laser safety and low energy systems for non-lethal use, and refining biological effects models to assess combat vulnerability to emerging optical threats.</p> <p>(U) \$5,617 Conducted bioeffects research to enable safe exploitation of lethal and non-lethal directed energy weapons, advanced communications systems, and radar by transitioning tri-Service High-Power Microwave (HPM) Ocular Hazards Study results to DoD and developed/provided data for policy review of Active Denial Technology (ADT) non-lethal weapon.</p> <p>(U) \$2,126 Developed and evaluated robust force protection bio-technology tools for Air Expeditionary Force commanders to assess chemical exposures and predict adverse human health and mission performance impacts.</p> <p>(U) \$94 Initiated multi-phase study of Photorefractive Keratectomy (PRK) as surgical method to reduce need for glasses or contact lenses for aircrew.</p> <p>(U) \$12,075 Total</p> <p>(U) <u>FY 2000 (\$ in Thousands)</u></p> <p>(U) \$3,220 Conduct laser optical bioeffects laboratory experiments and field research. Enables exploitation of laser technology while providing countermeasures for optical hazards/threats, with and without laser eye protection. Pursue assessments/evaluations of foreign directed energy weapons to better define threats and countermeasures. Initiate experiments with Federal Aviation Administration to introduce safe active lasing into aircrew operational environments to assess impact, improve tactics development, and define specific mission training requirements. Explore optical technologies to achieve information warfare dominance.</p> <p>(U) \$4,735 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of directed energy weapons, communications, and radar.</p>									
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<p>(U) <u>A. Mission Description Continued</u></p> <p>(U) <u>FY 2000 (\$ in Thousands) Continued</u></p> <p>Provide data on cancer development and birth defects for revised human exposure standard for ultra-wide band pulsed microwaves. Begin Air Expeditionary Force Agile Combat Support Initiative for portable High Energy Microwave Active Denial Technology. Conduct wave propagation modeling for information warfare applications.</p> <p>(U) \$546 Evaluate Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collect and analyze first year post-operative data.</p> <p>(U) \$8,501 Total</p> <p>(U) <u>FY 2001 (\$ in Thousands)</u></p> <p>(U) \$4,161 Conduct laser optical bioeffects laboratory experiments and field research. Enables exploitation of laser technology while providing countermeasures for optical hazards/threats, with and without laser eye protection. Initiate work with the United States Marine Corps Joint Non-Lethal Weapons Directorate to develop non-lethal laser use guidelines in compliance with DoD/International Policy while enhancing device effectiveness. Complete the personnel biological effects model to assess combat vulnerability to emerging optical threats. Develop and demonstrate technology to produce a safe, active lasing experience into aircrew simulators, leading to development and refinement of engagement tactics, countermeasures, and training requirements. Expand research in optical technology development for information warfare. Complete experiments with Federal Aviation Administration on safe active lasing.</p> <p>(U) \$5,978 Conduct radio frequency bioeffects laboratory experiments to enable safe exploitation of lethal and non-lethal directed energy weapons and radar. Continue Air Expeditionary Force Agile Combat Support initiative for portable High Energy Microwave Active Denial Technology. Complete studies of millimeter effects on skin cancer and corneal eye damage for DoD exposure guidance. Continue wave propagation modeling for information warfare applications.</p> <p>(U) \$500 Evaluate Photorefractive Keratectomy as surgical method to reduce aircrew need for glasses or contact lenses. Collect and analyze second year post-operative data.</p> <p>(U) \$10,639 Total</p> <p>(U) <u>B. Project Change Summary</u></p> <p>Not Applicable.</p>		
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<p>(U) <u>C. Other Program Funding Summary (\$ in Thousands)</u></p> <p>(U) Related Activities:</p> <p>(U) PE 0602720A, Environmental Quality Technology.</p> <p>(U) PE 0602777A, Systems Health Hazard Prevention Technology.</p> <p>(U) PE 0603231F, Crew Systems and Personnel Protection Technology</p> <p>(U) PE 0604706F, Life Support Systems.</p> <p>(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.</p> <p>(U) <u>D. Acquisition Strategy</u></p> <p>Not Applicable.</p> <p>(U) <u>E. Schedule Profile</u></p> <p>(U) Not Applicable.</p>		
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